What is claimed is:

1. A system for delivering a desired mass of gas, comprising:

a chamber;

a first valve controlling gas flow into the chamber;

a second valve controlling gas flow out of the chamber;

a pressure transducer providing measurements of pressure within the chamber;

an input device for providing a desired mass of gas to be delivered from the system;

a controller connected to the valves, the pressure transducer and the input device and programmed to,

receive the desired mass of gas through the input device,

close the second valve;

open the first valve;

receive chamber pressure measurements from the pressure transducer;

close the inlet valve when pressure within the chamber reaches a predetermined level;

wait a predetermined waiting period to allow the gas inside the chamber to approach a state of equilibrium;

open the outlet valve at time = t_0; and

close the outlet valve at time = t^* when the mass of gas discharged equals the desired mass.

2. A system according to claim 1, wherein the mass discharged Δm is equal to,

$$\Delta m = m(t_0) - m(t^*) = V/R[(P(t_0)/T(t_0)) - (P(t^*)/T(t^*))] \qquad (5)$$

wherein $m(t_0)$ is the mass of the gas in the delivery chamber at time = t_0, $m(t^*)$ is the mass of the gas in the delivery chamber at time = t^*, V is the volume of the delivery chamber, R is equal to the universal gas constant (8.3145 J/mol K), $P(t_0)$ is the pressure in the chamber at time = t_0, $P(t^*)$ is the pressure in the chamber at time = t^*, $T(t_0)$ is the temperature in the chamber at time = t_0, $T(t^*)$ is the temperature in the chamber at time = t^*.

3. A system according to claim 2, further comprising a temperature probe secured to the delivery chamber and connected to the controller, wherein the temperature probe directly provides $T(t_0)$ and $T(t^*)$ to the controller.

4. A system according to claim 3, further comprising a temperature probe secured to the delivery chamber and connected to the controller and wherein $T(t_0)$ and $T(t^*)$ are calculated using:

$$dT/dt = (\rho_{STP}/\rho V)Q_{out}(\gamma-1)T + (Nu\ \kappa/l)(A_w/VC_v\rho)(T_w - T) \qquad (3)$$

where ρ_{STP} is the gas density under standard temperature and pressure (STP) conditions, ρ equals the density of the gas, V is the volume of the chamber, Q_{out} is the gas flow out of the delivery chamber, T equals absolute temperature, γ is the ratio of specific heats, Nu is Nusslets number, κ is the thermal conductivity of the gas, C_v is the specific heat of the gas under constant volume, l is the characteristic length of the delivery chamber, and T_w is the temperature of the wall of the chamber as provided by the temperature probe.

5. A system according to claim 4, wherein the gas flow out of the delivery chamber is calculated using:

$$Q_{out} = -(V/\rho_{STP})[(1/RT)(d\rho/dt)-(P/RT^2)(dT/dt)] \quad (4)$$

6. A system according to claim 1, wherein the predetermined level of pressure is provided through the input device.

7. A system according to claim 1, wherein the predetermined waiting period is provided through the input device.

8. A system according to claim 1, further comprising an output device connected to the controller and the controller is programmed to provide the mass of gas discharged to the output device.

9. A system according to claim 1, further comprising a process chamber connected to the delivery chamber through the second valve.

10. A system according to claim 1, wherein the pressure transducer has a response time of about 1 to 5 milliseconds.

11. A system according to claim 1, wherein the second valve has a response time of about 1 to 5 milliseconds.

12. A method for delivering a desired mass of gas, comprising:

providing a chamber;

receiving a desired mass of gas to be delivered from the chamber;

preventing gas flow out of the chamber;

allowing gas flow into the chamber;

measuring pressure within the chamber;

preventing further gas flow into the chamber when pressure within the chamber reaches a predetermined level;

waiting a predetermined waiting period to allow the gas inside the chamber to approach a state of equilibrium;

allowing gas flow out of the chamber at time = t_0; and

stopping gas flow out of the chamber at time = t* when the mass of gas discharged equals the desired mass.

13. A method according to claim 12, wherein the mass discharged Δm is equal to,

$$\Delta m = m(t_0) - m(t^*) = V/R[(P(t_0)/T(t_0)) - (P(t^*)/T(t^*))] \tag{5}$$

wherein $m(t_0)$ is the mass of the gas in the delivery chamber at time = t_0, $m(t^*)$ is the mass of the gas in the delivery chamber at time = t*, V is the volume of the delivery chamber, R is equal to the universal gas constant (8.3145 J/mol K), $P(t_0)$ is the pressure in the chamber at time = t_0, $P(t^*)$ is the pressure in the chamber at time = t*, $T(t_0)$ is the temperature in the chamber at time = t_0, $T(t^*)$ is the temperature in the chamber at time = t*.

14. A method according to claim 13, further comprising measuring a temperature of a wall of the delivery chamber and the temperature measurements of the wall directly provide $T(t_0)$ and $T(t^*)$ to the controller.

15. A method according to claim 13, further comprising measuring a temperature of a wall of the delivery chamber and wherein $T(t_0)$ and $T(t^*)$ are calculated using:

$$dT/dt = (\rho_{STP}/\rho V)Q_{out}(\gamma-1)T + (Nu\ \kappa/l)(A_w/VC_v\rho)(T_w - T) \qquad (3)$$

where ρ_{STP} is the gas density under standard temperature and pressure (STP) conditions, ρ equals the density of the gas, V is the volume of the chamber, Q_{out} is the gas flow out of the delivery chamber, T equals absolute temperature, γ is the ratio of specific heats, Nu is Nusslets number, κ is the thermal conductivity of the gas, C_v is the specific heat of the gas under constant volume, l is the characteristic length of the delivery chamber, and T_w is the temperature of the wall of the chamber.

16. A method according to claim 15, wherein the gas flow out of the delivery chamber is calculated using:

$$Q_{out} = -(V/\rho_{STP})[(1/RT)(d\rho/dt)-(P/RT^2)(dT/dt)] \qquad (4)$$

17. A method according to claim 12, wherein the predetermined level of pressure is received through an input device.

18. A method according to claim 12, wherein the predetermined waiting period is received through an input device.

19. A method according to claim 12, further comprising providing the mass of gas discharged to the output device to an output device.

20. A method according to claim 12, further comprising connecting a process chamber to the delivery chamber for receiving the mass of gas discharged from the delivery chamber.